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Chemistry

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The work for the year in chemistry began with a study of fruits and leaves. The determination of the amount of moisture in the leaves led to the discussion of the question whether we were justified in assuming that the loss on evaporation was wholly water. Some facts seemed to indicate that we were not, as for instance, that the addition of water to the dried fruit does not restore it to its former flavor. One pupil heated some apple in a test tube, as gently as possible, and with the help of a condenser collected the moisture given off. Upon testing with litmus he discovered the liquid to be acid. The same pupil is trying to collect the moisture given up by the leaves at the temperature of the drying-oven.

The class concluded that we could not at present determine what substances were given off to cause the loss in weight upon the charring of the dried leaves, and this was left for future study. Nearly all recognized the carbon.

While the drying of the fruit and leaves was going on, the physical properties of water were studied as outlined, each pupil ascertaining certain facts for presentation to the class. The determination of the chemical composition of water by means of electrolysis, with a comparison of the volumes of the two gases formed, and the testing of each, is followed by the further study of hydrogen and its properties. After its preparation from zinc and acid, and the synthesis of water by the burning of a jet of hydrogen, the same gas is again obtained, by the action of sodium on water.

Each pupil prepares oxygen in the usual way with potassium chlorate and manganese dioxide, studies its properties, and writes a clear, concise outline of the subject, giving both the results of personal observation and of further study from reference books. The formation of oxides from the oxygen of the air is shown by igniting in an open crucible five grams of zinc dust or of pulverized iron, carefully weighed before and after heating. The zinc must be heated with care to avoid volatilizing the oxide. The student is asked to compare combustion in oxygen with that in air and to inquire what kind of substance is probably present in air in addition to the oxygen. If the questions of the class lead to it, the proofs that air is a mixture rather than a compound will be given. The following experiment will illustrate the composition of air and the properties of nitrogen:

> Wet the inside of a test tube and put in some iron filings, leaving in those that cling to the sides when the test tube is turned upside down. Invert the tube in water and leave for twenty-four hours. Insert a lighted splinter of wood in the gas remaining in the tube. Measure the water in the tube and the capacity of tube.

The student who has been able to do more rapid work than others may make the determination of the weight of a liter of air as follows:

> Place 25 c. c. of water in a stout flask of about 250 c. c. capacity, and boil until the interior is full of steam. Remove the lamp, cork the flask tightly, and allow it to cool. Weigh accurately. Draw the cork and determine the increase of weight. Find the volume of air weighed. From these values, calculate the weight of one liter

of air under the conditions of the experiment. The result is approximately correct.

A return to the work with the leaves shows carbon to be an important ingredient of these, and this element is next considered, and in connection with it the study of combustion will be continued. The following experiments, among others, will be used:

(a) Shut the holes of a Bunsen burner, and hold in the flame the edge of a cold, dry evaporator. Open the holes and see if you can burn off the black which collected.

(b) Sprinkle a very little powdered charcoal in the flame.

Examine the structure of your lamp. Explain the difference in the color of the flame when the holes are open and when they are shut.

Press down upon the gas-flame a piece of cold fine wire gauze.

Turn off the gas and hold the cold wire gauze about 6 inches above the burner. Turn on the gas again and hold a lighted match above the gauze.

State the three conditions necessary for combustion. Why does blowing a flame sometimes cause it to burn and sometimes extinguish it?

Insert a piece of wood in an ignition tube and hold in the flame of your lamp. Light the gas which comes off at the open end of the tube. Examine the residue and burn it on a piece of wire gauze.

Put a piece of glowing charcoal in a deflagrating spoon into a covered bottle full of air. When it ceases glowing, remove and insert a lighted match. Name the gas made. Pour in the bottle about 5 c. c. of lime-water and shake.

Test in the same way a bottle full of air.

Breathe through a short glass tube into a test tube containing 10 c. c. of lime-water.

Carbon dioxide will also be obtained from marble, and the test for carbonates given; as a product of fermentation; by the action of yeast on molasses; and as a product of decay.

Dissolve 5 c. c. of molasses in 50 c. c. of water. Fill a test tube with the mixture, and add to it a little yeast. Invert the test tube in an evaporating dish filled with more of the mixture (the clamp of the ringstand may be used to keep the test tube in place), and leave until the next exercise. Then pour the gas into 5 c. c. of lime-water in another test tube.

The questions, Is there carbon dioxide in the air? Why not in large amount? What becomes of it? will lead to a consideration of the relation of this gas to the life of the plant, and the source of some of the carbon found in the fruit and leaves.

Throughout the work constant reference is made to the materials with which the course started, in order to give a definite aim to the investigations, and to form in the mind of the pupil a clear image of the processes and results of plant activity. Mathematics has been introduced in the calculation of percentages of water and carbon in leaf and fruit, of the amounts of oxygen and hydrogen in the water of the leaf, and in the estimation of the proportion of these different elements in the whole plant, and in similar problems. Incidentally the pupils have learned the metric system, the use of the centigrade thermometer, and its translation into Fahrenheit, and have acquired some skill in bending glass and other manipulations, and in weighing.